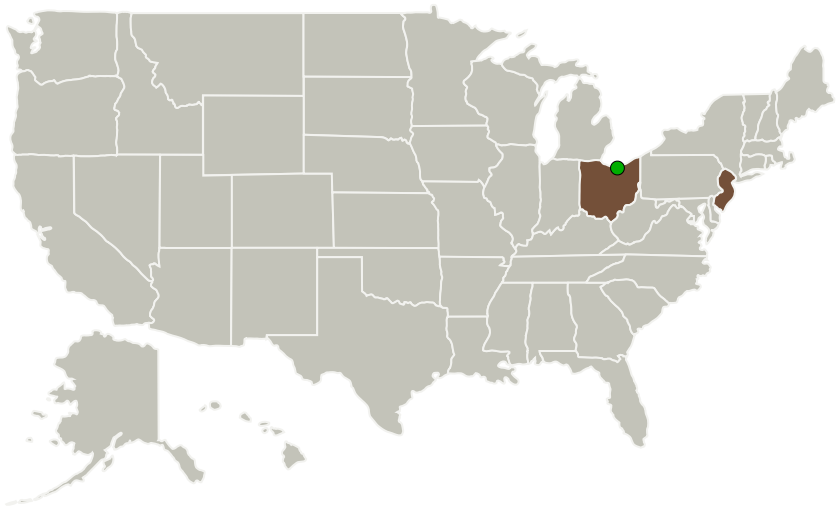
# A Novel Compact and Reliable Hybrid Silicon/Silicon Carbide Device Module for Efficient Power Conversion, Phase I

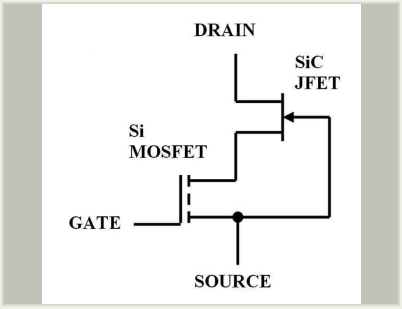
Completed Technology Project (2013 - 2013)

## Project Introduction

United Silicon Carbide, Inc. proposes to develop a novel compact, efficient and high-temperature power module, based on unique co-packaging approach of normally-off silicon (Si) MOSFET with silicon carbide (SiC) normally-on power JFET in a cascode configuration. A much desired silicon MOS gate control is provided readily compatible with the conventional gate drivers, making a proposed module a plug-in replacement for conventional Si IGBT modules offering smaller size and higher power density, lower conduction and switching losses, and higher operating temperature for a wide range of civilian, aerospace and military applications, where compact power converters are needed with minimum cooling requirements. The proposed hybrid Si/SiC cascode approach offers substantial improvement in module power density, by up to 50%, with unique packaging approach, greatly reduced size of a power switch, and elimination of separate antiparallel diode, which is replaced with an intrinsically fast and efficient body diode of a low-voltage Si MOSFET. Significant reduction in static and dynamic power losses compared to Si IGBTs and SiC MOSFETs are achieved by utilization of a fast switched normally-on SiC JFET with ultra-low on-resistance and hence much lower static and dynamic losses than state-of-the-art Si IGBTs and SiC MOSFETs. It is hard to understate the need for compact power converters in aerospace applications, where the allowed on-board space and the weight for the power management systems are very limited. The proposed cascode power module will also enable circuit designers to provide significantly smaller, more reliable, more efficient and lower cost solutions for more mainstream applications such as power factor correction circuits, photovoltaic micro-inverters, power supplies, motors & pump drives, industrial power converters, and consumer appliances .

## Primary U.S. Work Locations and Key Partners



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| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| United Silicon Carbide, Inc. | Lead Organization | Industry | Monmouth Junction, New Jersey |
| Glenn Research Center(GRC) | Supporting Organization | NASA Center | Cleveland, Ohio |

| Primary U.S. Work Locations | |
|---|---|
| New Jersey | Ohio |

## Project Transitions

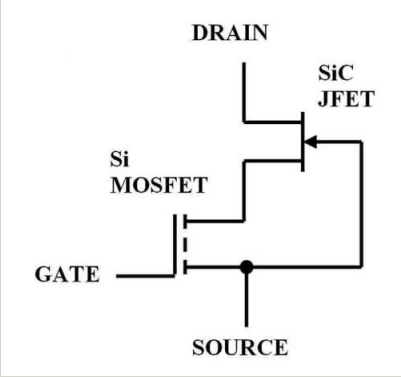
**May 2013:** Project Start

**November 2013:** Closed out

**Closeout Documentation:**

- Final Summary Chart*(https://techport.nasa.gov/file/137837)*

## Images




**Project Image**
A Novel Compact and Reliable Hybrid Silicon/Silicon Carbide Device Module for Efficient Power Conversion
*(https://techport.nasa.gov/image/130164)*

## Organizational Responsibility

**Responsible Mission Directorate:**
Space Technology Mission Directorate (STMD)

**Lead Organization:**
United Silicon Carbide, Inc.

**Responsible Program:**
Small Business Innovation Research/Small Business Tech Transfer

## Project Management

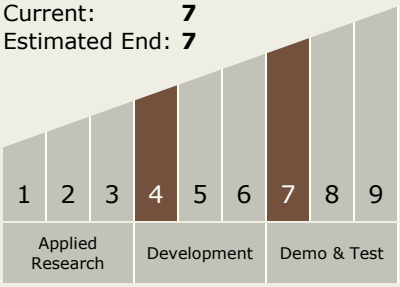
**Program Director:**
Jason L Kessler

**Program Manager:**
Carlos Torrez

**Principal Investigator:**
Leonid Fursin

## Technology Maturity (TRL)

Start: **4**
Current: **7**
Estimated End: **7**



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## Technology Areas

**Primary:**

- TX03 Aerospace Power and Energy Storage
  - TX03.3 Power Management and Distribution
    - TX03.3.3 Electrical Power Conversion and Regulation

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System